

REPORT DOCUMENTATION PAGE

Form Approved
OMB NO. 0704-0188

Public Reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comment regarding this burden estimates or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188,) Washington, DC 20503.

1. AGENCY USE ONLY (Leave Blank)		2. REPORT DATE 15 Dec 00		3. REPORT TYPE AND DATES COVERED Final 2 Mar 98 – 1 Dec 00	
4. TITLE AND SUBTITLE Instrumentation for Chemical Sensing and Computational Applications of Molecularly Linked Networks of Nanoscale Metallic Clusters		5. FUNDING NUMBERS G- DAAG55-98-0095 A I			
6. AUTHOR(S) R.P. Andres, R.P. Reifenberger, D.B. Janes					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Purdue Research Foundation 1021 Hovde Hall, Room 200 W. Lafayette, IN 47907-1021		8. PERFORMING ORGANIZATION REPORT NUMBER			
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U. S. Army Research Office P.O. Box 12211 Research Triangle Park, NC 27709-2211		10. SPONSORING / MONITORING AGENCY REPORT NUMBER		<i>38247.1-PH-R1P</i>	
11. SUPPLEMENTARY NOTES The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other documentation.					
12 a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution unlimited.			12 b. DISTRIBUTION CODE		
13. ABSTRACT (Maximum 200 words) The instrumentation purchased under this Grant includes: 1) an inert atmosphere glove box, 2) a clean room work station, 3) a variable temperature probe station, and 4) an Omicron UHV STM/AFM. These instruments are critical to the DOD funded research at Purdue involving fabrication and characterization of prototype chemical sensor and nanoscale computational elements involving molecularly linked networks of nanometer scale metallic clusters					
14. SUBJECT TERMS Nanoelectronics, metal clusters, instrumentation, linked cluster networks					15. NUMBER OF PAGES 4
					16. PRICE CODE
17. SECURITY CLASSIFICATION OR REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION ON THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT UL		

20010516 114

Final Report Grant DAAG55-98-0095

Department of the Navy
Office of Naval Research

Ronald P. Andres

School of Chemical Engineering

Ronald P. Reifenberger

Department of Physics

David B. Janes

School of Electrical and Computer Engineering

PURDUE UNIVERSITY

West Lafayette, IN 47907

An interdisciplinary team of researchers at Purdue University involved in several research projects supported by ARO, DARPA, and NSF submitted a 1998 DURIP Equipment proposal entitled "Instrumentation for Chemical Sensing and Computational Applications of Molecularly Linked Networks of Nanometer Scale Metallic Clusters" to the Army Research Office (ARO Proposal NO. 38247-PH-RIP). This proposal was funded as Grant DAAG55-98-0095. A summary of the instrumentation purchased under this Grant is listed below.

<u>ITEMS</u>	<u>COST</u>
1)Inert Atmosphere Glove Box, Vacuum Atmospheres Co. (and Taylor-Wharton liquid nitrogen transfer cylinder)	\$27,500
2)Laminar Flow Hood and Clean Room Work Station, Terra Universal, Inc.	\$11,275
3)Sony camera and optics, Navitar Inc.	\$5,550
4)Variable Temperature Probe Station, MMR Technologies	\$21,900
5)Misc. items for UHV Chamber, Kurt Lesker and Thermionics Northwest	\$7,100
6)Omicron UHV STM/AFM	\$52,000
7)Misc. scientific equipment, Keithley Instruments, EG&G, Tektronix, Yamaha, Digital Instruments	<u>\$21,175</u>
	TOTAL
	\$146,500

The first three items on the above list are critical for fabrication of prototype chemical sensors and nanoscale computational elements. Fabrication of

DISTRIBUTION STATEMENT A

Approved for Public Release
Distribution Unlimited

these complex structures, which include reactive organic molecules and in the case of our DARPA research easily oxidized GaAs substrates, requires steps in which the substrate is protected from exposure to both oxygen and water vapor. These steps are done in the inert atmosphere glove box. The fabrication of these devices also involves colloidal application of metallic nanoparticles. During these steps, it is critical that the substrate be manually manipulated but not exposed to airborne particulates, and these steps are carried out in the laminar flow hood.

The Vacuum Atmospheres glove box was itemized on the original proposal to include a refrigerator and a Nikon dark field microscope. It became evident as the research progressed that the refrigerator was not critical and the laminar flow hood and clean room work station (Item 2) was purchased in lieu of the refrigerator. The Sony camera and optics (Item 3) was purchased in lieu of the dark field microscope listed in the original proposal.

Item 4, the MMR variable temperature probe station listed in the original proposal, is being used as a controlled environment/variable temperature chamber for electrical measurements. The probe station has been modified to allow the chamber to be filled with various gases, or to be used under vacuum (Items included in Item 7). The probe station is interfaced with computer-controlled electrical test equipment (Items included in Item 7) to allow current-voltage measurements on various samples. This electrical measurement capability allows the characterization of devices realized using networks of metallic nanoclusters. Specifically, nanoelectronic devices consisting of nanoclusters linked by organic molecules are in turn linked to contact pads, so that their response can be monitored in the probe station. Devices characterized to date include prototype chemical sensor devices, nanostructured electronic conductors, and novel semiconductor device structures.

The items listed as Item 5 were used to construct a UHV chamber as described in the original proposal. The original concept was to construct a pre-treatment chamber to be used in conjunction with a Park UHV-STM that is used for making scanning probe electrical measurements on nanoelectronic structures. As our research progressed it became evident that this Park STM (although a valuable part of the nanoelectronic facilities at Purdue) was not able to fully characterize the devices we were fabricating. Thus, a request was made to ARO to use \$52,000 from the grant as part of the purchase price of an Omicron UHV STM/AFM (Item 6).

The Omicron STM/AFM is a state of the art instrument that allows both STM and AFM studies of a wide variety of nanostructures in a controlled UHV environment. The \$125,000 cost of this instrument was shared (roughly equally) between three different grants. It combines various STM and AFM measurement modes including contact mode AFM with simultaneous lateral force detection and non-contact mode AFM in a single instrument. In addition, the instrument allows multi-mode imaging i.e. the simultaneous acquisition of several AFM and STM related signals such as tunneling current, force, and force gradient in a single image. This instrument will significantly expand our scanning probe capabilities.

The items grouped under Item 7 include an EG&G Digital Signal Processor Lock-in, a Keithley low-current amplifier, Digital Instruments nanoprobe, vacuum fittings, and a vacuum pump. These are items used in the probe station and the UHV scanning microscope facilities dedicated for electrostatic measurements on molecules and nanocontacts.